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Biologists Study Evolution of Animal Cooperation

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Survival of the fittest is a simple reality in the game of life. Successful play necessarily requires a degree of selfishness, but across the animal kingdom species have evolved social behaviors. Why? Do they enhance survival?

"Many of us are really fascinated with the wide spectrum of social behavior we see across the diversity of animal taxa," said Janis Dickinson, an evolutionary biologist at the University of California at Berkeley.

A predominant theory of social evolution is kin selection, which notes that it is advantageous for individuals to help their relatives because it increases the number of their shared genes in future generations. An alternative hypothesis is that helpers increase their own survival and future reproduction by cooperating with others, said Dickinson.

While it is true that animal altruists tend to be related to the individuals they help, whether they do so because of kin selection or simply because their neighbors happen to also be relatives has been a long-standing debate among evolutionary biologists.

Two reports in the June 20 issue of the journal *Science* highlight a few of the key issues surrounding the study of social behavior and offer some insight to how, why, and with whom certain animals opt to cooperate.

The studies' findings diverge regarding the importance of kinship in this phenomenon, prompting Dickinson and colleague Walter Koenig to conclude in a perspective article on these research papers that "progress in understanding social evolution will involve teasing apart the importance of kinship from other forms of selection."

Crowing for Kin

Critics of the kin selection theory argue that social families of moms, dads, brothers, sisters, cousins, aunts, uncles, and so forth are simply a side-effect of the fact that offspring do not stray too far from home when they reach maturity.

If this is truly the case, it leaves open the possibility that kin-based cooperation is merely a consequence of dispersal patterns: Helpers can only help family because family is all that is around to help.

A genetic study of carrion crows (*Corvus corone corone*) in which males serve as nannies to breeding pairs shows that certain males do stray far from the nest at maturity, but actively seek a nest of their own kin to settle in.

As in other cooperative breeders, carrion crow nannies are usually offspring that do not stray far from the nest and thus have no choice between helping relatives or unrelated individuals.

However, after about two years some young—mostly males—eventually disperse and when they do they tend not to settle on neighboring territories, according to the study authors Vittorio Baglione, Daniela Camestrari, and Jan Ekman of Uppsala University in Sweden and José Marcos at the University of Sevilla in Spain.

The researchers banded 334 young crows over a six-year period and only four of those banded settled on neighboring territories. Before settling, the scientists note, the crows check out several territories, socially interacting with the resident crows before selecting a home.

"In our best documented case, we observed how a banded immigrant yearling prospected two territories [twice each] occupied by groups that had already been banded, and eventually settled on the one held by an older sibling that had dispersed in the previous year," the authors write in *Science*.

The scientists conclude that this indicates the crows are actively seeking to settle with kin, rather than provide evidence of a result attributed simply to dispersal patterns.

"It suggests that some information is getting passed on showing where relatives are, perhaps by family visits, or that there is some other form of recognition," said Dickinson.

Lizard Rock-Paper-Scissors

A team of U.S. and French scientists' study of male side-blotched lizards (*Uta stansburiana*) adds a new twist to the social evolution puzzle. Cooperation among the lizards tends to occur between genetically similar, but not related, individuals.

"We show a completely new mechanism by which individuals can find genetically similar individuals with which they are more likely to cooperate," said Barry Sinervo, a professor of ecology and evolutionary biology at the University of California at Santa Cruz.

The lizards belong to three different genetic categories that correspond to the color of their throats: blue, orange, and yellow. The categories are called morphs. Each morph exhibits a unique mating strategy.

Sinervo likens the mating strategy to the game of rock-paper-scissors that humans play.

In the game rock-paper-scissors, rock beats scissors, scissors beat paper, and paper beats rock. Among the lizards, orange beats blue, blue beats yellow, and yellow beats orange. The result is a stable population in which no single colored lizard can dominate.

The orange males are aggressive "usurpers" that take over the mates of blues. The yellow males are "sneakers" because they mimic females and sneak behind the back of orange males to cuckold them, or steal their mate. The blue males are "guarders" that watch over their mates and chase off yellow sneakers, but lose out against the usurpers.

In the study, Sinervo and colleague Jean Clobert at Université Pierre et Marie Curie in Paris, France, found that blue males tend to establish territories close to other blue males. DNA analysis shows that the blue males are more genetically similar than would be expected by chance, but that they are not kin.

"They triple each other's fitness by associating with genetically similar [blue] males that are not related," said Sinervo.

By contrast, the orange males tended to avoid settling near other orange males since they would suffer a decrease in fitness if they had a genetically similar neighbor.

Throat color in the side-blotched lizard is controlled by the combination of two alleles, a type of TK, at a single position on the chromosome. What Sinervo finds intriguing is that a range of behavioral, physiological, and life-history traits are correlated with throat color.

The male colored morphs show differences not only in the way they interact with other males, but also in how they disperse from their birthplace and choose a territory to settle in, as well as in their hormone levels, immune systems, and other physiological traits.

"In order to make it in the world [the lizards] have alleles for throat color, but also the alleles must be working well with the rest of the genome," said Sinervo.

Dickinson and Koenig write in their perspective that taken together, the carrion crow and side-blotched lizard studies suggest that "genetic recognition mechanisms may be more widespread and sophisticated than previously suggested."

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